A REPORT ON THE TROPHIC STATUS OF KILLARNEY, WAHTOPANAH, ROSSMAN AND SANDY LAKES

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INTRODUCTION

The "participation programme" was initiated in 1978 in response to requests for water quality information by concerned cottage owners on many of the recreational lakes in Manitoba. Previous studies have shown that the enrichment status of a lake can be estimated by the use of Secchi disc readings (transparency) and chlorophyll a concentrations (the green pigment in algae) which indicate water clarity and algal densities, respectively.

Volunteers are supplied with sampling kits which include a Secchi disc, a composite water sampler, one litre bottles, magnesium carbonate preservative and instructions. Participants are requested to take weekly Secchi disc measurements and samples during the ice free period of the year. Water samples are preserved and shipped to the Technical Services Laboratory in Winnipeg, where they are analyzed for chlorophyll a. Analyses of the chlorophyll a and Secchi disc results are indicative of the relative trophic status of each lake. Long term sampling over a number of years is indicative of trends in nutrient enrichment.

It is essential that a sampling program on a lake be continued over a period of five to ten years in order to determine if there is a trend toward accelerated enrichment. In many lakes, temporary degradation of water quality occurs during periods of extensive algal blooms. The fluctuation in algal populations occurs both seasonally and from year to year and is caused by environmental factors such as sunlight and mineral

chemical and biological activity. Over the long term, however, definite increases in chlorophyll *a* would be indicative of accelerated enrichment (eutrophication) which could be induced by the addition of man generated nutrients.

Sources of nutrients are sink and laundry wastes (especially phosphate detergents), and seepage from septic tank systems and pit privies. All lake users should be aware of the potential problems which can be caused by these sources of nutrients and that they can contribute to the impairment of recreational aesthetic water quality. If over the long term it becomes apparent that man generated nutrients are contributing to accelerate eutrophication, then these sources would have to be identified and steps would have to be taken to minimize their effects.

This report includes a map or maps showing sampling stations, weekly chlorophyll *a* and Secchi disc values, mean annual chlorophyll *a* and Secchi disc values and trophic state indices. The trophic state indices (0-100) developed by Carlson (1977) are derived from mean annual chlorophyll *a* and Secchi disc values.

NOTE: Water taken from lakes for domestic uses should be boiled or disinfected and as is stated in the Public Health Act of Manitoba:

> All surface waters should be considered unsafe for domestic purposes unless boiled or otherwise disinfected . . .

RESULTS AND DISCUSSION

Chlorophyll a and Secchi disc values were collected from three stations on each of Killarney Lake, Lake Wahtopanah (Rivers Reservoir), Rossman Lake and Sandy Lake as shown in Figure 1. Mean chlorophyll a and Secchi disc values collected each week in 1979, 1980 and 1981 are shown in Tables 1 through 4 for Killarney, Wahtopanah, Rossman and Sandy Lakes, respectively. The mean annual chlorophyll a and Secchi disc results are shown in Table 5 and illustrated in Figure 2.

Mean chlorophyll a concentrations reflect the level of algae in each lake. Low algae populations are indicated by chlorophyll a levels at or near 4 µg/l as noted in Sandy Lake in 1979 and Rossman Lake in 1981. High algae populations are indicated by chlorophyll a levels between 8 and 12 µg/l as noted in Rossman Lake in 1980. Generally algae levels above 12 µg/l can be considered nuisance algae. Nuisance algae levels occurred in Rossman Lake in 1979 only, and in Killarney Lake and Lake Wahtopanah in 1979, 1980 and 1981. Although there were nuisance algae levels in Killarney Lake, mean chlorophyll a levels were less than 20 µg/l and considerably better than the excessively high chlorophyll a levels of 80.3 and 55.7 µg/l noted in Lake Wahtopanah in 1979 and 1980 respectively (Figure 2). It is also notable that the mean chlorophyll a in Lake Wahtopanah showed considerable improvement in 1981 when it dropped to 13.8 µg/l.

The water clarity measured by Secchi disc was good in Sandy Lake, moderately good in Rossman Lake and fair in Lake Wahtopanah and

Killarney Lake. The mean annual Secchi disc results ranged from 2.6 to 3.4 m in Sandy Lake; 1.4 to 1.9 m in Rossman Lake; 1.2 to 1.5 m in Lake Wahtopanah and 0.9 to 1.9 m in Killarney Lake (Table 5). The 1981 Secchi disc results for Sandy Lake would have been higher except that the total depth at station WQ 504 was only 1.75 m.

Carlson's (1977) trophic status indices (TSI) for chlorophyll a and Secchi disc have been noted for each station sampled from 1979 through 1981 (Table 5). Trophic state indices near 40 indicate mesotrophic or moderately enriched status while indices near or more than 60 indicate eutrophic or enriched status. Sandy Lake is mesotrophic with some tendency toward eutrophy and Rossman Lake is mesotrophic to eutrophic in character. Killarney Lake is eutrophic and appears to be relatively stable. Algae blooms on Lake Wahtopanah caused high chlorophyll a levels and TSI values for chlorophyll a in Lake Wahtopanah in 1979 and 1980 (Tables 2 and 5). The considerably lower chlorophyll a levels and TSI values for chlorophyll a in Lake Wahtopanah in 1979 may have been due to the use of nutrients by Cladophora sp. (matted filamentous algae) or rooted aquatic plants which cannot be sampled with a composite chlorophyll a sampler.

Subsequent data collection will more clearly delineate the trophic status and water quality of each of these lakes and to establish long term trends.

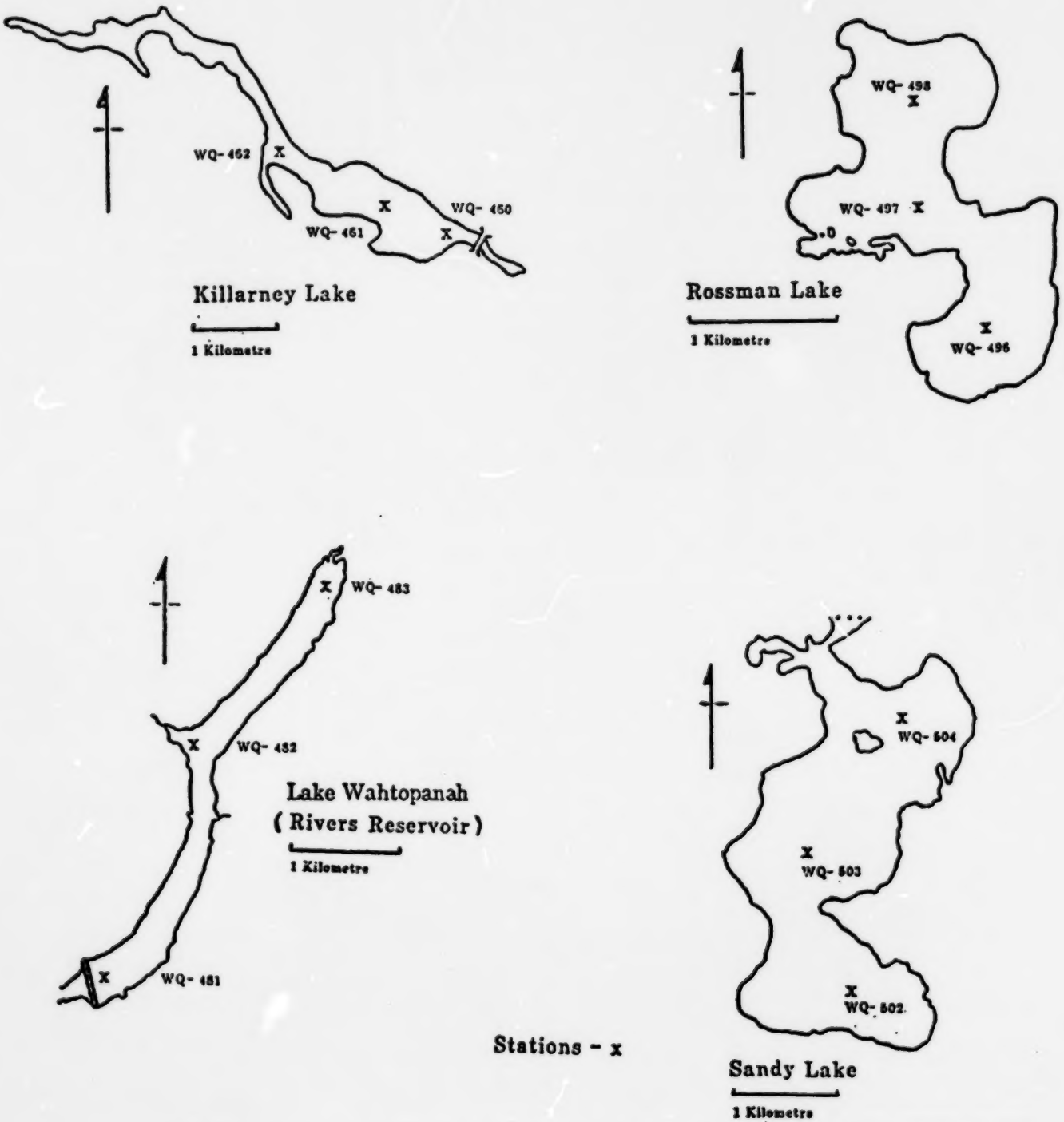

Figure 1: Water quality stations on Killarney, Wahtopanah, Rossman and Sandy Lakes.

TABLE 1. Mean chlorophyll a (µg/l) and mean Secchi disc (m) values for Killarney Lake during 1979, 1980 and 1981.

Date	Chlorophyll a (µg/l) [1]	Secchi Disc (m) [1]
May 22, 1979	81.1	0.8
May 29, 1979	14.1	1.3
June 5, 1979	14.1	1.3
June 12, 1979	13.3	1.4
June 19, 1979	5.1	2.8
June 26, 1979	3.5	3.1
July 3, 1979	3.9	3.5
July 10, 1979	9.4	2.6
July 17, 1979	11.6	2.3
July 24, 1979	15.6	1.6
August 3, 1979	15.6	1.6
August 8, 1979	42.1	1.3
August 14, 1979	19.2	1.3
August 21, 1979	16.2	1.4
August 25, 1979	14.9	1.4
May 13, 1980	8.5	1.3
May 20, 1980	10.0	1.2
May 27, 1980	9.3	1.1
June 3, 1980	11.9	0.8
June 10, 1980	12.2	1.0
June 17, 1980	10.6	0.8
June 24, 1980	17.6	0.8
July 1, 1980	19.8	1.0
July 8, 1980	8.9	0.9
July 15, 1980	20.8	1.1
July 22, 1980	27.1	1.2
August 5, 1980	26.2	1.1
August 12, 1980	13.5	0.8
August 19, 1980	31.3	0.9
August 26, 1980	14.4	0.8
May 12, 1981	9.1	1.3
May 19, 1981	7.3	1.3
May 26, 1981	31.8	1.5
June 2, 1981	32.5	0.8
June 9, 1981	14.2	0.8
June 16, 1981	37.0	0.8
June 23, 1981	4.9	0.8
June 30, 1981	4.1	0.8
July 7, 1981	10.7	0.8
July 14, 1981	18.5	0.8
July 20, 1981	30.3	1.0
July 28, 1981	29.0	0.8
August 3, 1981	19.6	0.8
August 11, 1981	26.0	0.7
August 18, 1981	19.5	0.8
August 25, 1981	17.7	0.8

[1] Each reported value for 1979, 1980 and 1981 as a mean of values from Stations WQ460, WQ461, and WQ462.

TABLE 2. Mean chlorophyll a (µg/l) and mean Secchi disc (m) values for Lake Wahtopanah (Rivers Reservoir) 1979, 1980 and 1981.

Date	Chlorophyll a (µg/l) [1]	Secchi Disc (m) [1]
May 23, 1979	11.2	0.5
May 30, 1979	11.1	0.8
June 13, 1979	8.1	1.2
June 20, 1979	4.4	1.3
June 27, 1979	9.2	2.2
July 4, 1979	9.3	2.0
July 11, 1979	9.3	1.8
July 18, 1979	70.4	2.1
July 25, 1979	143.0	0.8
August 1, 1979	353.3[a]	1.4[a]
August 8, 1979	145.8	0.5
August 15, 1979	173.3	0.6
August 22, 1979	47.6	0.5
August 26, 1979	127.9	0.5
May 14, 1980	20.1	1.3
May 21, 1980	14.0	2.5
May 28, 1980	2.9	3.6
June 4, 1980	3.4	2.9
June 11, 1980	10.1	2.8
June 18, 1980	27.6	1.8
July 2, 1980	23.7	1.2
July 9, 1980	27.7	0.8
July 17, 1980	245.6	0.8
July 23, 1980	10.9	1.1
July 30, 1980	107.4	0.8
August 6, 1980	112.6	0.7
August 13, 1980	16.4	1.3
August 21, 1980	74.8	0.5
August 27, 1980	137.4	0.5
May 13, 1981	1.6	3.2
May 20. 1981	6.9	1.5
May 27, 1981	4.2	1.8
June 3, 1981	4.7	1.7
June 10, 1981	4.0	1.6
June 17, 1981	5.3	1.5
June 24, 1981	2.4[b]	2.1
July 1, 1981	6.2	1.6
July 7, 1981	6.9	1.1
July 15, 1981	24.7	0.9
July 22, 1981	19.7	0.8
July 29, 1981	6.5	1.6
August 5, 1981	29.0	0.7
August 12, 1981	78.8	0.7
August 19, 1981	9.2	0.6
August 26, 1981	7.0	0.5

[1] Each reported value for 1979, 1980 and 1981 is a mean of values from Stations WQ481, WQ482 and WQ483 except as noted.

[a] Station WQ481, August 1, 1979 unusually high chlorophyll a at 798 µg/l and Secchi disc at 3m.

[b] Station WQ482, June 24, 1981 chlorophyll a not analyzed.

Table 3. Mean chlorophyll a µg/l and mean Secchi disc(m) values for Moorman Lake during 1979, 1980 and 1981

Date	Chlorophyll a (µg/l)[1]	Secchi Disc (m)[1]
May 31, 1979	26.3	1.1
June 7, 1979	12.4	1.8
June 14, 1979	6.7	2.6
June 21, 1979	11.6	2.5
July 5, 1979	8.8	1.3
July 12, 1979	13.3	1.6
July 19, 1979	12.3	1.8
July 26, 1979	19.8	1.3
August 3, 1979	35.8	1.1
August 9, 1979	8.7	1.1
August 16, 1979	21.1	1.5
August 23, 1979	19.7	1.1
August 27, 1979	18.7	1.1
May 15, 1980	1.3	2.1
May 26, 1980	6.6	2.8
May 29, 1980	4.6	2.8
June 5, 1980	3.9	3.1
June 12, 1980	4.9	1.8
June 19, 1980	2.6	1.4
June 26, 1980	3.8	2.3
July 3, 1980	3.0	2.2
July 16, 1980	2.6	2.3
July 18. 1980	11.0	1.8
July 24, 1980	11.9	1.5
July 31, 1980	28.5	1.3
August 7, 1980	18.6	1.0
August 14, 1980	51.4	0.7
August 22, 1980	16.7	0.8
August 28, 1980	8.3	0.8
May 14, 1981	5.9	1.7
May 21, 1981	4.7	1.8
May 28, 1981	4.6	2.1
June 4, 1981	2.3	2.1
June 18, 1981	2.5	1.9
June 25, 1981	3.3	1.8
July 2, 1981	6.4	1.7
July 9, 1981	6.8	1.4
July 23, 1981	13.2	1.2
July 30, 1981	25.4	0.9
August 6, 1981	12.7	0.8
August 18, 1981	5.5	0.7
August 27, 1981	6.5	0.9

[1] Each reported value for 1979, 1980 and 1981 is a mean of value from Stations WQ 496, WQ 497 and WQ 498.

Table 4. Mean Chlorophyll a ($\mu g/l$) and mean Secchi disc (m) values for for Sandy Lake during 1979, 1980 and 1981.

Date	Chlorophyll a ($\mu g/l$)[1]	Secchi Disc (m)[1]
June 1, 1979	14.2	1.8
June 8, 1979	5.9	2.4
June 15, 1979	2.0	3.3
June 22, 1979	4.5	4.3
June 29, 1979	2.5	3.8
July 6, 1979	5.2	2.7
July 13, 1979	6.7	2.4
July 20, 1979	3.8	2.6
July 27, 1979	20.0	2.3
August 3, 1979	11.8	2.0
August 10, 1979	21.1	1.6
August 16, 1979	7.3	1.4
August 24, 1979	5.7	2.7
August 27, 1979	5.6	2.7
May 15, 1980	3.3	2.3
May 26, 1980	2.4	2.5
May 29, 1980	3.6	2.8
June 5, 1980	2.1	2.7
June 12, 1980	1.3	3.6
June 19, 1980	1.4	3.6
June 26, 1980	1.4	3.3
July 3, 1980	0.6	3.8
July 10, 1980	1.1	3.4
July 18, 1980	NA[a]	3.4
July 31, 1980	2.1	3.2
August 7, 1980	4.1	3.1
August 14, 1980	3.1	2.3
August 22, 1980	4.2	2.5
August 28, 1980	5.7	2.8
May 14, 1981	2.5	3.9
May 21, 1981	2.6	3.8
May 28, 1981	2.4[b]	3.8
June 4, 1981	1.4	3.9
June 18, 1981	1.7	3.5
June 25, 1981	1.8	3.9
July 2, 1981	2.6	3.3
July 9, 1981	2.1	3.4
July 23, 1981	7.3	3.2
July 30, 1981	6.8	3.4
August 6, 1981	6.0	3.3
August 18, 1981	7.5	2.8
August 27, 1981	7.9	2.7

[1] Each reported value for 1979, 1980 and 1981 is a mean of values from Stations WQ502, WQ503, and WQ504.

[a] No chlorophyll a analysis July 18, 1980.

[b] Station WQ502, chlorophyll a not analyzed, May 28, 1981.

Table 5: Mean chlorophyll a ($\mu g/l$) and Secchi disc (m) per station and the equivalent trophic state index (Carlson, 1977) for each parameter and station 1979, 1980 and 1981.

Lake	Station	1979 Chlorophyll a ($\mu g/l$) Mean ± SD	1979 TSI	1979 Secchi Disc (m) Mean ± SD	1979 TSI	1980 Chlorophyll a ($\mu g/l$) Mean ± SD	1980 TSI	1980 Secchi Disc (m) Mean ± SD	1980 TSI	1981 Chlorophyll a ($\mu g/l$) Mean ± SD	1981 TSI	1981 Secchi Disc (m) Mean ± SD	1981 TSI
Killarney Lake	WQ460	17.6±20.2	58.7	1.9±0.7	50.7	16.2±9.0	57.8	1.0±0.2	60.7	19.3±10.6	59.6	0.9±0.3	59.6
	WQ461	17.7±18.8	58.8	1.8±0.8	51.5	16.3±7.9	58.0	1.0±0.2	60.0	20.1±10.4	59.9	0.9±0.2	59.9
	WQ462	20.6±22.0	60.2	1.8±0.8	51.5	15.5±6.0	57.4	1.0±0.2	60.0	19.3±11.4	59.7	0.9±0.2	59.7
	Mean	18.6±20.0		1.8±0.8		16.0±7.6		1.0±0.2		19.5±10.6		0.9±0.2	
Lake Wahtopanah (Rivers Reservoir)	WQ481	150.0±22.6[a]	79.8	1.6±1.5	52.9	41.1±49.8	67.0	1.5±1.1	54.3	14.1±18.4[b]	56.5	1.4±0.7	55.0
	WQ482	46.5±53.6	68.2	1.2±0.7	57.9	60.3±76.0	70.8	1.7±1.2	52.5	13.8±19.7[b]	56.3	1.5±0.9	54.0
	WQ483	43.7±58.0	67.6	0.6±0.2	66.4	65.5±86.7	71.6	1.2±0.8	57.1	13.6±20.1	57.3	1.1±0.5	58.1
	Mean	80.3±11.3[a]		1.2±0.8		55.7±71.6		1.5±1.0		13.8±19.0[b]		1.4±0.7	
Rossman Lake	WQ496	19.1±13.1	59.5	1.6±0.5	53.6	10.6±10.7	53.7	1.9±0.9	50.9	7.5±5.5	50.3	1.5±0.6	54.4
	WQ497	16.1±7.8	57.8	1.5±0.6	53.8	12.6±14.5	55.4	1.9±0.9	50.4	7.9±8.0	50.8	1.4±0.5	54.7
	WQ498	14.5±5.3	56.8	1.5±0.5	53.8	11.8±13.4	54.8	1.9±0.9	50.7	7.6±5.9	50.4	1.4±0.5	54.8
	Mean	16.6±9.3		1.5±0.5		11.7±12.7		1.9±0.9		7.6±6.4		1.4±0.5	
Sandy Lake	WQ502	7.1±4.9	49.8	2.5±1.4	47.0	2.3±1.4[a]	38.9	3.0±0.5	44.0	4.5±2.8[b]	45.3	4.1±0.4	39.6
	WQ503	9.7±10.4	52.9	2.8±1.1	45.2	2.6±1.5[a]	40.0	3.5±0.8	41.9	4.0±2.7	44.1	4.6±0.7	38.0
	WQ504	8.1±5.8	51.1	2.4±0.8	47.2	3.0±1.9[a]	41.4	2.6±0.5	46.4	3.8±2.5	43.8	1.6±0.3	53.0
	Mean	8.3±7.3		2.6±0.9		2.7±1.6		3.0±0.8		4.1±2.6		3.4±1.4	

a) August 1, 1979 Chlorophyll a of 798 $\mu g/l$ inordinately high and Secchi Disc of 3m also high.
b) No analysis June 24, 1981

a) No analysis July 18, 1980
b) No analysis May 28, 1981

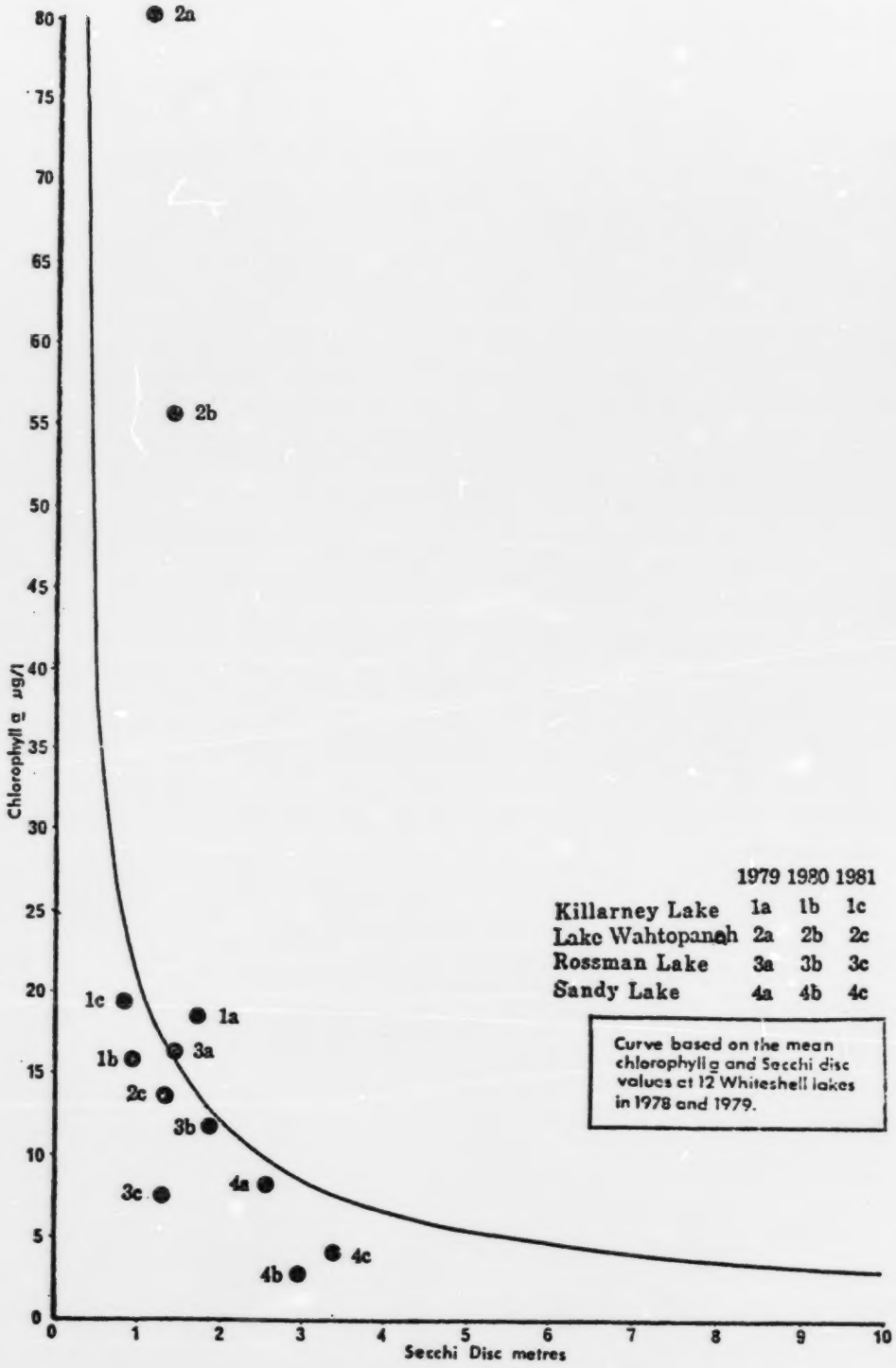
Chlorophyll a µg/l
Secchi Disc metres
1979 1980 1981
Killarney Lake 1a 1b 1c
Lake Wahtopanah 2a 2b 2c
Rossman Lake 3a 3b 3c
Sandy Lake 4a 4b 4c
Curve based on the mean chlorophyll a and Secchi disc values at 12 Whiteshell lakes in 1978 and 1979.

Figure 2: Chlorophyll a and Secchi disc values for Killarney, Wahtopanah, Rossman and Sandy Lakes.

GLOSSARY OF TERMS

ALGAE - an assemblage of simple, mostly microscopic non-vascular plants containing photosynthetic pigments such as chlorophyll. Algae occur suspended in water (phytoplankton) and attached to rock and other suitable substrates. Some algae may produce nuisance conditions when environmental parameters are suitable for prolific growth.

CHLOROPHYLL - the photosynthetic green pigment which occurs in all groups of algae.

EUPHOTIC ZONE - the lighted region that extends vertically from the water surface to the level at which photosynthesis fails to occur due to insufficient light penetration.

EUTROPHIC - waters containing a rich supply of plant nutrients that support heavy growths of algae and aquatic plants. The increase in algae causes a decrease in the penetration of light. Deep areas may exhibit oxygen depletion due to the decomposition of dead organisms. Eutrophic lakes tend to be shallow and support warm water species of fish. The degradation in water quality renders the lake unsuitable for many recreational activities.

EUTROPHICATION - the process of becoming increasingly enriched in nutrients. It refers to the entire complex of changes which accompanies increasing nutrient enrichment. The result is the production of dense nuisance growths of algae and aquatic weeds which generally degrade water quality and render the lake unsuitable for many recreational activities. Accompanying the increase in algae is a decrease in game fish and an increase in coarse fish.

MESOTROPHIC - waters characterized by a moderate nutrient supply and organic production (i.e. midway between eutrophic and oligotrophic). The waters are suitable for most recreational activities.

OLIGOTROPHIC - waters containing a poor supply of plant nutrients resulting in little algae and aquatic plant growth. The waters are generally clear permitting extensive light penetration. Oxygen in the bottom waters is abundant. Oligotrophic lakes tend to be deep and support cold water fish such as lake trout and whitefish. The lakes are well suited for all types of recreational activities.

SECCHI DISC - a circular metal plate, 20 centimeters in diameter, the upper surface of which is divided into four equal quadrants and so painted that two quadrants directly opposite each other are painted black and the intervening ones white. The Secchi disc is used to estimate the depth of the euphotic zone.

TROPHIC STATUS - depending upon the degree of nutrient enrichment and resulting biological productivity, lakes are generally classified into three intergrading types: oligotrophic, mesotrophic and eutrophic. If the supply of nutrients to an oligotrophic lakes is progressively increased, the lake becomes more mesotrophic in character; with continued enrichment, it will become eutrophic.

µg/l - micrograms per litre or parts per billion

LITERATURE CITED

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Province of Manitoba. 1981. Public Health Act. Revised Regulations P210-R3, Division VII, Section 57.